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THE RELATION OF SNOW COVER TO WINTER KILLING IN CHAMAEDAPHNE CALYCVLATA*

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During the course of a piece of investigation at the University of Michigan during 1910-1912, some interesting observations and measurements were made upon *Chamaedaphne calyculata*, a heath plant which grows in the peat bogs of the vicinity.

The winter of 1910-11 was normal for southern Michigan. No extremely low temperatures were recorded and the snow, although above the average during the early part of the winter, was below it during the coldest weather, so that at the time of severest cold (-20° C.) the bushes of *Chamaedaphne* were less than half protected. The cold spells were of short duration, however.

The winter of 1911-12 was extreme both in amount and duration of cold and of snow. New records were set both for the absolute minimum and for the duration of severe cold.

Before entering into the main subject a brief account of the vegetational history of *Chamaedaphne* will be advantageous. During the early part of a growing season the shoots of the year develop large (2-4 cm. long) leaves. Towards the end of the growing period small leaves, in whose axils are flower buds, are produced. Both large and small leaves remain on the bush over winter. With approaching winter the green color of the leaves is replaced by a dark reddish brown, the petioles become red, and the leaves bend up into an upright position. With the

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advent of spring the leaves gradually regain their green color and their summer position. The flowers appear early in spring, and later the shoots of the year appear from nodes back of the inflorescence. As these shoots develop the older leaves gradually die and drop off.



FIG. 1. General view in the Mud Lake Bog at the time of deepest snow, showing the *Chamaedaphne* covered with snow except where exposed by brushing away the snow from a path. Spruce and tamarack in the background. March 16, 1912.

At the time of blooming in 1911, during the latter part of April, the bushes were green clear to the tops and flowering was profuse. Although dead leaves and flower buds could be found here and there, their presence did not affect the general appearance of green vegetation.

The spring of 1912 was radically different. Blooming was later, occurring in the first week of May and, although rather profuse, the general impression was one of dead brown leaves and dead flower branches. Only by looking very carefully or better by walking among the bushes could one really realize that the plants were in bloom and that the old leaves had greened-out.

A most striking feature however was the remarkable transition between flowers in bloom, and greened-out leaves and dead leaves and buds, which occurred about two thirds to three fourths of the height of the bushes from the ground. It was noticeably higher in the centers of large bushes and in wind-protected areas and lower in wind-swept and less protected areas. It corresponded remarkably to the general level of the snow which partly covered the bushes during the severe and unusually prolonged cold weather of February, 1912.



FIG. 2 A view in the Mud Lake Bog at the time of flowering, showing the dead buds at the tops of the bushes. The snow level was about 70 cm. May 9, 1912.

Observations had been made nearly every week all winter and before the severest cold weather the snow was 50 to 66 cm. (20-26 inches) deep in the *Chamaedaphne* association, varying according to the exposure to wind. All during the very cold weather the depth of snow at First Sister Lake, west of Ann Arbor, Michigan, was more than 20 inches and in places reached heights of 75 to 90 cm. (30-35 inches) on the general level of drift.

At Mud Lake, north of Ann Arbor, where *Chamaedaphne* occurs in the openings in the spruce and tamarack, the snow was regularly deeper, a general level being 80 to 90 cm. (31-36 inches) and up to 110 cm. (43 inches). In wind-sweeps the snow level during the very cold weather was about 50 cm.

In order to express the results other than through general impression by eye, in May, 1912, the per cent of dead flower buds out of the total number of buds produced in the spring of



FIG. 3. Twigs of *Chamaedaphne*, in the upper the outer end killed. (From material collected at Mud Lake, May 9, 1912.)

1911 was ascertained for different levels above the ground. Strips 20 cm. wide running from the outside of the bush to the center were selected and the total number of blossoms and dead buds were counted in 10 cm. intervals from the ground to the top of the bush and the results tabulated.

In every case where bushes had been entirely covered with snow, the per cent of blossoms was 98-100 per cent of possibility. Where the bush was only partly covered, at the snow level, there was an abrupt change in the per cent of blossoms from about 80 per cent and higher to less than 30 per cent and to zero in the tops of the higher bushes. When flowering occurred at all

above the snow line it was only the basal two or three buds, while a flowering shoot normally contains about a dozen flowers (6 to 19).

One might say that it was natural for the outer parts of the *Chamaedaphne* to die back each year, but it was repeatedly observed both at First Sister Lake and at Mud Lake that long bent over stems (sometimes 2 meters in length) which remained below the snow line were profusely flowered, while short stems (sometimes as short as 15 cm.) on hummocks in the center of clumps, which projected the greater part of their length above the snow, were uniformly killed back.

Killing was probably due to too thorough drying out of the exposed parts and not to freezing. It may be doubtful whether actual freezing had taken place as the leaves and twigs, while attached to the bushes, remained pliable in the lowest temperatures tested (-24° C.), whereas the same twigs soon became brittle when severed from the plant.

TABLE SHOWING THE RELATION OF SNOW LEVEL TO WINTER KILLING IN *Chamaedaphne calyculata* (L.) MOENCH

(The first two examples are taken from data obtained at First Sister Lake and the others from Mud Lake bog. The first column under each example is the total number of flowers buds produced in 1911, while the second column is the per cent. which were killed during the winter of 1911-12. Numbers in italics are based upon parts of the plants above the snow level.)

Cm.	I		II		III		IV		V		VI		VII	
	Snow 56 cm.		Snow 65 cm.		Snow 85 cm.		Snow 85 cm.		Wind sweep snow 55 cm.		Snow 80 cm.		Snow 72 cm.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
90-100			<i>18</i>	<i>100</i>			<i>32</i>	<i>100</i>						
80-90	80	99	<i>149</i>	<i>98</i>	34	0	<i>61</i>	<i>71</i>						
70-80	466	92	<i>108</i>	<i>57</i>	97	0	96	0	8	100	182	0	10	100
60-70	317	80	<i>100</i>	<i>50</i>	92	0	72	0	122	98	31	0	115	3
50-60	161	27	<i>115</i>	<i>17</i>	—	—	9	0	54	59	—	—	124	0
40-50	168	17	74	0	—	—	—	—	61	5	—	—	85	0
30-40	212	2	130	3	—	—	—	—	—	—	—	—	55	0
20-30	—	—	—	—	—	—	—	—	—	—	—	—	18	0
0-20	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The natural distribution of *Chamaedaphne* is northern and throughout its range it is usually efficiently protected from the drying effect of severe prolonged cold by a covering of snow.

Recurring, severe, prolonged cold weather will kill it down to the snow level and the occurrence of such cold without an adequate snow protection must be at least one of the important limitations to the distribution of this plant in places which would otherwise be suitable for it.

UNIVERSITY OF MICHIGAN

SHORTER NOTES

SHADE-INDUCED UPRIGHTNESS IN THE SEASIDE SPURGE.—For some years my attention has been drawn to the behavior of *Euphorbia polygonifolia* L. as it grows in abundance upon the sand along the New Jersey coast. When growing in the open, the plants lie flat upon the sand and form attractive patches, the closely-forked stems varying in color from a pale green in some individuals to that of a bright red in others.

However when the plants chance to be among any shore grass the aspect is so changed that one might pass them by as of another species. Instead of the thick-set, stout, many-jointed plant it assumes an upright position and the internodes are several inches in length. Such plants do not thrive in even the partial shade of the slender-leaved grass and probably rarely set seed.

By subjecting very young plants, started in the full sun, to the shade of twigs stuck into the sand near them the writer has been able to note the taking on of the upright habit. When the plants have already become prostrate the artificial shade brought to them will induce a turning upward of the tips of the stems.

Many kinds of prostrate plants exhibit this tendency to become erect in the shade, but none seem to be more sensitive than the spurge in question.

BYRON D. HALSTED

ANCIENT AND MODERN VIEWS REGARDING THE RELATION OF TAXONOMY TO OTHER PHASES OF BOTANICAL WORK.—In the April number of *TORREYA*, Dr. P. A. Rydberg in his article on "Phytogeography and its Relation to Taxonomy and Other Branches of Science" says a few words in defense of taxonomic